CAMOUFLAGE BY REFLECTANCE: REPORT OF FIELD TEST

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2. Effectiveness of the reflectance technique in camouflaging a tank.

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Report of Field Test

Contract No. DAAD05-73-C-0325

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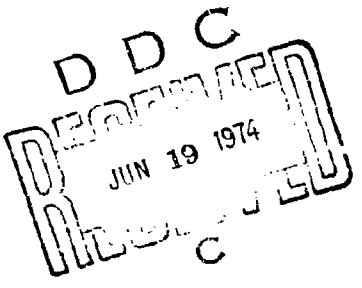

May 1974

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ABSTRACT

A week-long evaluation of the camouflage by reflectance system was performed at the General Electric Ordnance Systems test area in Pittsfield, Mass. Testing here was done using an M113 vehicle with wheel mock-ups to simulate an M60 tank as no tank was available in this area. Further testing was performed at Aberdeen Proving Ground using an M60 tank as the test bed.

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INTRODUCTION

Tests were conducted on the reflective camouflage system at the contractor's facilities in Pittsfield, Mass., and at the Aberdeen Proving Ground, Maryland. The objective of the tests was to evaluate the hardware from the aspect of the user and the observer.

The reflective camouflage system is designed to mount on the M60 tank using the sprocket and compensating idler wheels as the primary attachment points. Since no M60 was available in Pittsfield, an M113 personnel carrier was adapted by mounting M60 wheels at appropriate locations to simulate the M60 configuration. The M60 fender was simulated by mounting bar stock at the appropriate dimensions and relationship to the M60 wheels. This mock-up configuration is shown in Figure 1. Since the system was designed to conceal the hull only of the M60, substituting the turretless M113 vehicle allowed a more objective evaluation of the system from the observers viewpoint, since only a relatively small proportion of the M113 needed to be camouflaged by other means. Evaluation from the user's aspect was somewhat limited since stowage on the tank turret could not be tried, and the mounting configuration could not be made exactly equivalent to the M60 tank. However, the basic procedures of deploying and disassembling the system were exercised.

The configuration of the Pittsfield test area did not allow a separation between the target and observer of the 500 meter effective distance specified as a system goal in the contract. However, no detection of the target was made beyond 350 meters so the facility proved large enough to evaluate the effectiveness of the camouflage system.

Initial testing was conducted at the General Electric test area in Pittsfield, Mass.

No formal training was given the user test crews (General Electric technicians). They were shown the hardware, given the Instruction Manual and had a briefing on the objectives of the tests. One practice deployment and disassembly exercise was allowed before data was taken.

Observers were other GE technicians and office workers recruited on the basis of a availability.

Observer tests were run by allowing the observer 3 minutes, at the initial observation point, to search for the vehicle. If the vehicle was not detected within the 3-minute period, the observer then walked in the general direction indicated by the Test Director until he finally detected the camouflaged vehicle. There were 3 observer tests conducted for each vehicle location.

The final field testing of the system was done at Aberdeen using an M60 tank, with both LWL and General Electric personnel taking part. The equipment was mounted on an M60 tank for form-and-fit trials. Test results are covered later in this report. Some minor modifications to the equipment were required and these were done at the LWL model shop.

For a more detailed description of the Camouflage system used please refer to the Final Report, "Terrain Reflectance Camouflage System for M60 Tank" Contract No. DAAD05-73-C-0325 November 26, 1973.

Section II

INTEGRATED TEST PLAN

The feasibility in principle of camouflage by reflectance had been demonstrated under a previous contract during which a jeep was successfully concealed with a reflective screen. The current program is intended to show the practicality of the reflectance technique applied to the hull of an M60 tank.

TEST OBJECTIVES

The general objective of the field test is to evaluate the effectiveness of the system from the standpoint of the user and the viewpoint of the observer. Both aspects are subjective in nature and do not lend themselves to precise measurement. However, the time required to perform various functions was recorded, and photographs made to illustrate the system effectiveness under various environmental and simulated combat conditions.

PROCEDURES

A Test Director was assigned the overall responsibility of conducting a series of tests consisting of the erection of the system at a location approximately 500 meters from the initial observation point; a number of observer tests after the erection; followed by a stowage test. The general vehicle locations were chosen to exercise the system under as many terrain and lighting conditions as possible.

Descriptions of user and observer test procedures are given on the following pages.

USER TEST PROCEDURES

Required Equipment

1) M60 wheel mock-up on M113 vehicle
2) Reflective shield system
3) Stopwatch
4) Wind speed indicator

Required Personnel

1) Test director
2) M113 driver
3) "Tank crew" (2)

Procedures

For the user tests, the Test Director designated the area in which the vehicle was to be located so that the desired background and lighting were presented to the observers. The vehicle crew maneuvered the vehicle to present the left front quadrant toward the observer area. The tank crew was timed during the process of erecting the camouflage system, with elapsed time being recorded for both the front and the side screens. After erection, the crew signalled to the test director that the system was in place and all user comments were recorded. (At this time, observer tests were conducted.) On signal from the Test Director, the crew disassembled the system, again recording the elapsed time, and stowed the system according to the Instruction Manual. Stowage times and comments were recorded.

OBSERVER TEST PROCEDURES

Required Equipment

1) Stopwatch
2) Rangefinder

Required Personnel

1) Test director
2) Observer
3) Photographer

Procedures

The Observer was brought to the initial observation point and the Test Director indicated the general direction in which the vehicle was located. The stopwatch was started as the Observer began his search and stopped when the Observer indicated he had positively located the vehicle. If, after 3 minutes, the vehicle had not been located from the initial point, the Observer walked in the general direction of the vehicle while continuing his search. When the Observer located the tank, the Test Director verified the location and the view was recorded photographically. Test Data Sheets were completely by all Observers.

Section III

RESULTS - PITTSFIELD TEST

USER TEST RESULTS

A two-man tank team erected the front and side screens in 7-8 minutes, and disassembled them in 5-6 minutes. Difficulty was experienced in attaching to the aluminum left front compensating idler wheel during the first trials. The cam mechanism was redesigned with knurled rings to increase the bearing surface, thereby improving the operation considerably. Weather conditions varied from clear to a light drizzle. Winds up to 7-1/2 mph occurred during installation. The results are summarized in Figure 2.

Site Selection

The test area contained a limited number of locations for optimum effectiveness of the system. In each case a man at the observer point would direct the tank to a spot that appeared to present the desired similarity between background and foreground. Tank test locations varied from 210 to 430 meters from the observer point, and one special test from the roof of Ordnance Plant 2 (about 15 meters high) at a distance of 1000 meters.

The test area had very few trees of any size. The usual tank location was in 1 to 2-feet tall bushes, with minimal clearance around the tank to allow for equipment installation.

Hardware Evaluations

The following are specific comments by the 'tank team' concerning hardware difficulties:

1. The left front wheel plate was difficult to install and would fall out if excessive torque was applied when tightening the side screen. (Subsequent modification of the cam mechanism improved operation considerably.)
2. The top clamps were designed to be quite flexible to accommodate various terrain. This flexibility detracts from their effectiveness since the clamp hangers give with the wind. Part of this difficulty was due to the flexibility of the fender simulator on the M113 vehicle and the inability to use the track on the M113 as the lower anchor (as was intended for the M60). The clamps have been redesigned to a more rigid configuration.

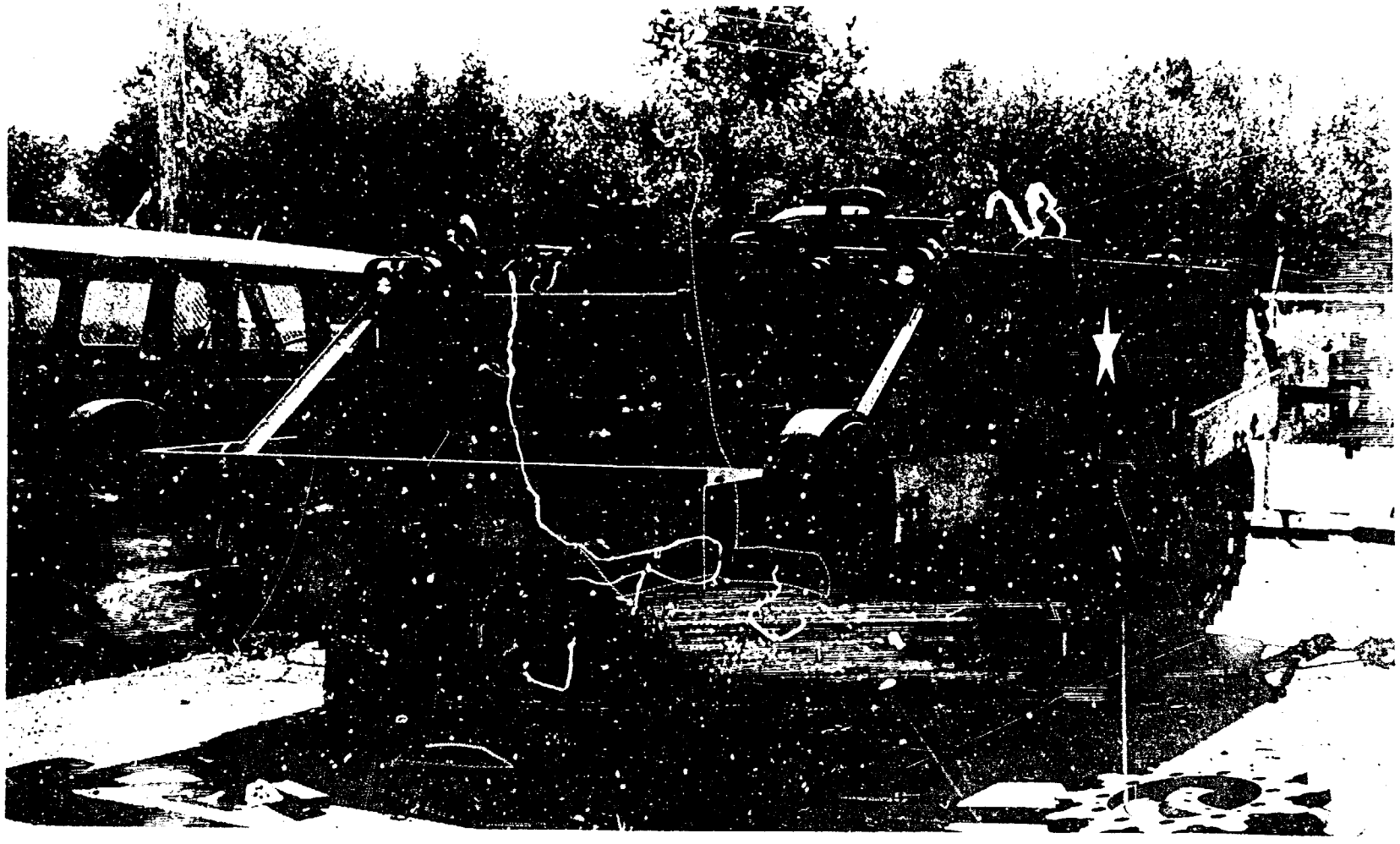


Figure 1. M60 Wheels Mounted on M113

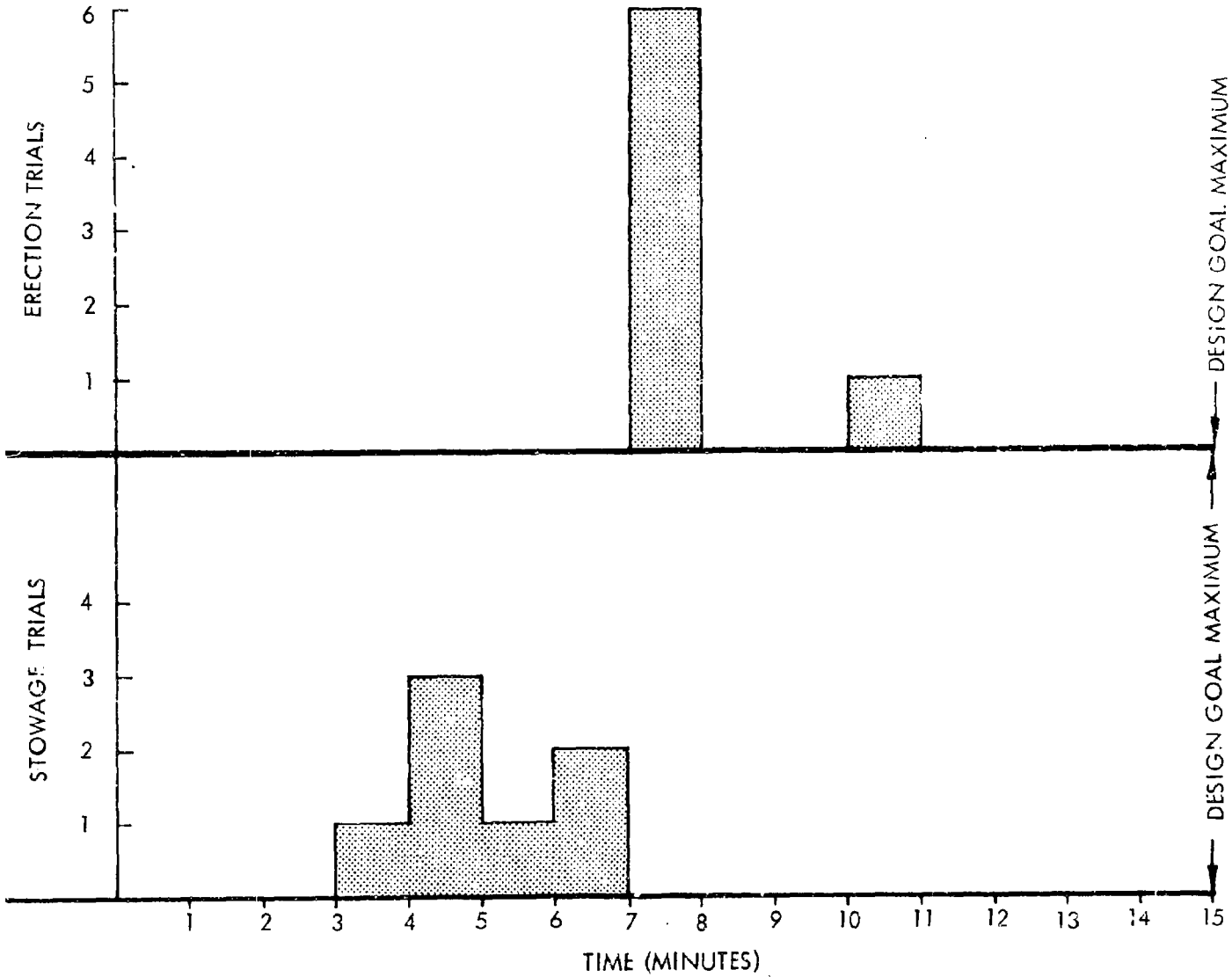


Figure 2. User Test Results

3. The locating pins for arm orientation tended to push out easily. This was corrected before delivery.

4. For both front plates, the top arm brackets were misaligned by about 1/16th-inch, making installation of the arms difficult. This was caused by loose bolts which were tightened before delivery.

A total of seven erection and stowage tests were performed during the Pittsfield tests. The hardware worked well with the exceptions noted above, as evidenced by the performance times summarized in Figure 2.

OBSERVER TEST RESULTS

Results of the observer tests indicated that under certain conditions of terrain, wind, and lighting, untrained personnel may approach to within 50 meters before locating the tank. The average detection distance was approximately 230 meters.

A summary of the observer tests are shown in Figure 3. Each test is represented by a "path" along which the observers are located (at the distance where they detected the vehicle). The paths do not indicate the actual routes followed by the observers; but are meant to clarify the test results. At the bottom of the figure, each test is shown and with the number of observers for each test and their detection times.

Figures 4 and 5 are typical views of the vehicle from an observation point before and after the camouflage was applied.

The following clues were primary contributors to detection by the observers:

1. Whenever the wind blew or gusted above 5 mph, the screens (particularly the side screen) would waver enough to be spotted if the observer was looking in that area from short range.

2. With the sun behind the vehicle from the observer, especially low in the sky, the screen reflects its own shadow. When parked against trees or high bushes the (shadow) reflection is not obvious; however, in an open area or low scrub, the shadow appears as a large dark area that was noted by several observers at a range of 300 meters or less.

3. When the background and foreground are not perfectly similar, the rectangular shape projected by the screen is noticeable (nature does not usually produce such geometric shapes). This clue is detectable within 250 meters and possibly more when the background is some distance from the vehicle. The use of cut brush to break up the straight lines improved the camouflage considerably.

4. The doors of the mirror cases were not covered by mirror material for tests 1 thru 4 and were somewhat conspicuous from distances below 250 meters. Covering the doors with the mirror was some help; however this presents a vertical mirror edge that could reflect skylight.

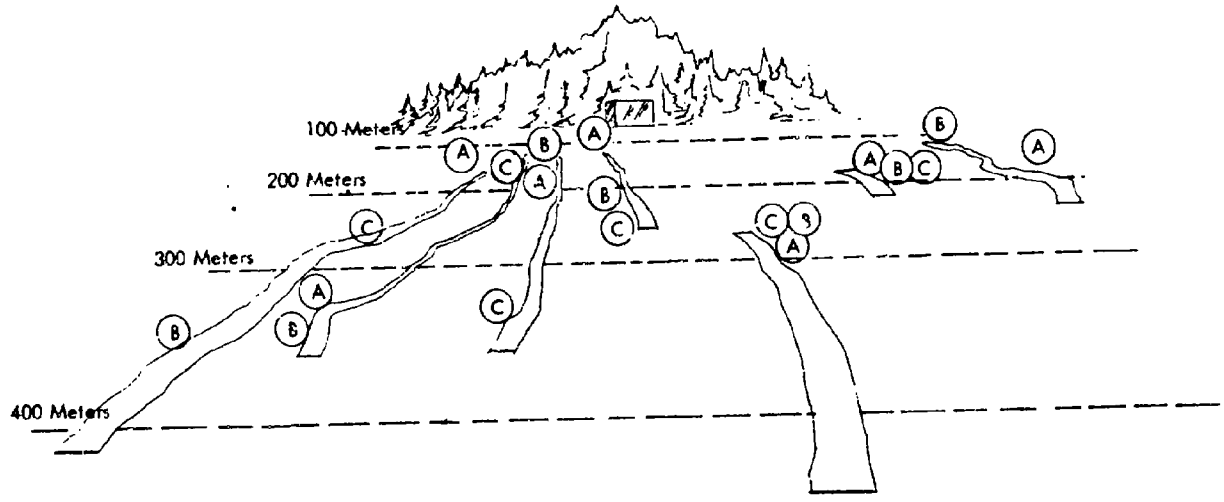
Tests were conducted on the evening of 13 September 1973 using night vision devices furnished by MERDC.* Two devices were used; Starlight Scope AN-PBS-2A and Infrared Thermal Viewer and Detector AN-PAS-7. The object of the tests was to determine the effect the reflective camouflage system would have on detectability with these aids. The sky was generally clear and the moon was full.

The results of testing using the IR viewer showed that at 170 meters, the camouflaged vehicle was not detected, even though the precise location was known. At 95 meters, the vehicle was not detected although a man moving around the venicle was discernable. The engine was then started and the vehicle was detected but was not identifiable. At 35 meters, the vehicle with the engine running was detectable as an "unknown object"; when the mirrors were removed, the vehicle was identifiable.

At a range of 170 meters, using the starlight scope, a moving man was detectable; the camouflaged vehicle was not. At 95 meters, the vehicle was detectable with the mirrors removed; it was not detectable with the mirrors in place. At 35 meters, the vehicle was detectable but not identifiable. With the mirrors removed, the vehicle was identifiable at 35 meters.

On the basis of this testing, it was concluded that the camouflage by reflectance system considerably reduces the detection distance when using the night equipment described above.

*Mobility Equipment Research and Development Center.



TEST 1 3 Observers	TEST 2 3 Observers	TEST 3 3 Observers	TEST 4 3 Observers	TEST 5 3 Observers	TEST 6 3 Observers	TEST 7 2 Observers
(A) 11 1/2 min.	(A) 2 min.	(A) 6 min.	(A) 9 min.	(A) 8 min.	(A) 3 min.	(A) 7 1/2 min.
(B) 5 1/2 min.	(B) 2 min.	(B) 13 min.	(B) 3 min.	(B) 4 1/2 min.	(B) 2 min.	(B) 10 min.
(C) 6 1/2 min.	(C) 11 1/2 min.	(C) 3 min.	(C) 1 min.	(C) 7 min.	(C) 1 min.	

Figure 3. OBSERVERS TEST RESULTS

Figure 4. Overall View Before Camouflage

Figure 5. Overall View After Camouflage

Section IV

ABERDEEN FIELD TEST & DEMONSTRATION

The final field test consisted of a demonstration of the camouflage by reflectance system applied to an M60 tank at Aberdeen. The demonstration was conducted by LWL and General Electric personnel at Aberdeen Proving Ground during the week of 10 October 1973. The equipment was mounted on an M60 tank for form-and-fit trials. Some minor modification to the equipment was required and this was accomplished in the LWL model shop.

On 10 October a most satisfactory test site was rejected due to a number of dud shells imbedded in the ground. The tank was moved to a less satisfactory location on Spesutie Island. The location was less satisfactory due to maximum observation range limitation of about 250 meters. The M60 was located inside and close to the edge of a wooded area with a yellowish-green grass field up to the tree line. The tank axis was set about 45° to the line-of-sight so that the viewing axis was a diagonal drawn from forward starboard to rear port. The reflective screens were set up on both the starboard side and forward end of the vehicle. The position of the vehicle in the tree line did not allow for any azimuth corrections without damage to the trees. Since the screens were mounted at 90° to each other, it was difficult to achieve an optimum reflective position. Particularly when sunlit, the yellow-green grass reflected image projected into the dark treeline presented a detectable color and brightness differential. Low bushes or small trees would have been more a desirable foreground. However, observation tests were conducted and at ranges of about 200 meters and greater, the reflector system appeared to satisfactorily conceal the M60 tank hull.

Barracuda nets and artificial foliage were used to conceal the tank turret above the reflector surface (see Figure 6). Toward the left in Figure 6, the mirror works quite well, reflecting foreground that matches the background. Toward the right, the artificial foliage used tended to be quite dark due to the deep folds in the paper used to make it. This presented an undesirable horizontal line (the top of the reflector against the dark artificial foliage).

Approximately 15 people from LWL and MERDC met at the test site at 7:30 pm on 10 October for night testing with electronic sighting devices. No active devices were provided. Image intensification of IR and visible light, thermal and starlight hand-held devices were used. The location of the camouflaged tank was known to most observers as they had been present during the daylight tests. The viewing range was almost 200 meters.

The image seen in the starlight scopes was generally identifiable as "something", but never as an M60 tank. The image was not very sharp however, (for example, people were identified as "people" at close ranges, but not as individuals, by name). The general opinion was that had the exact location not been known, the camouflaged tank site would not have been located, nor the tank identified.

The thermal viewing device did a much better job of locating the camouflaged tank because of a somewhat darker image against the treeline. Indications point to the temperature of the Mylar screens being closer to the ambient air temperature than the higher mass, warmer trees. The Mylar screens were disassembled and observations made from the original viewing position. The tank then presented a very bright image against the tree background and clearly identifiable as a tank. The vehicle had made a 10-mile run about 5 hours earlier and had retained enough heat to present a very bright image in the scope. Again, the camouflaged tank would not have been identified if the location had not been known.

The following morning, the tank was moved to another location with better cover for the moving light. This location had high grass and bushes at the edge of and into the tree line. This allowed image projection of trees and bushes which matched the color, texture and brightness of the background (see Figure 7). This location provided the camouflaged M60 tank satisfactory cover.

This concluded the demonstration. Two modifications to the reflective screen were suggested by the tests. One to make the near surface of the mirror non-reflective and the second, to break up the visual presentation of the top edge of the mirror to eliminate the horizontal line shown under some background conditions. These modifications were made at General Electric by painting the near surface with flat black acrylic lacquer primer and by painting a camouflage color pattern on the front surface to provide a visual scalloped effect.

Figure 6. Aberdeen Test Site (With Artificial Foliage)

Figure 7. Aberdeen Test Site